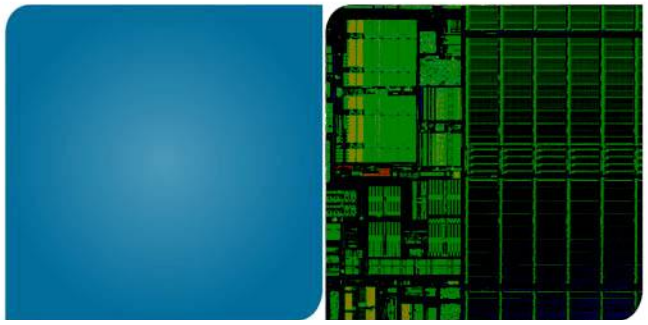
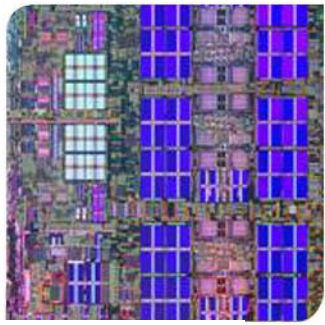

Computer Architecture Research Opportunities in Mobile Computing

Celebrating Yale@75
Sep 19 2014

Hyesoon Kim

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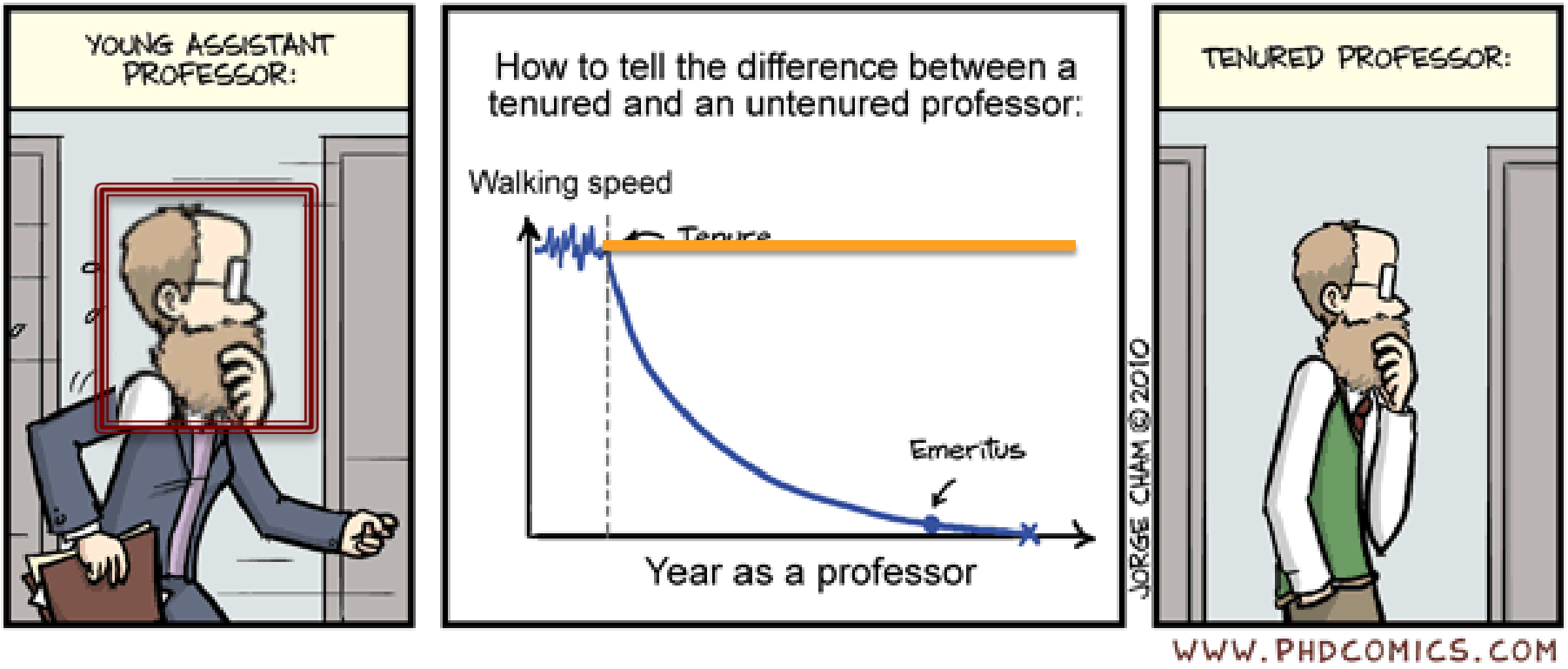

YOUNG ASSISTANT PROFESSOR:
How to tell the difference between a tenured and an untenured professor:
Walking speed
Tenure
Emeritus
Year as a professor
JORGE CHAM © 2010
TENURED PROFESSOR:
WWW.PHDCOMICS.COM

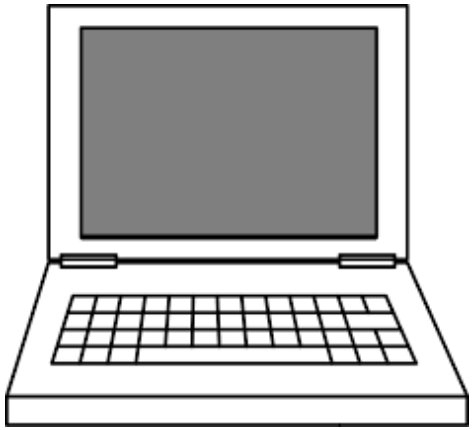
Walking mate
Fri, 19 Jul 2013
10341
You have reached your steps goal
8.15km
Distance
695kcal
Calories
Pause

12:45
7304 steps

Issues in Mobile Computing

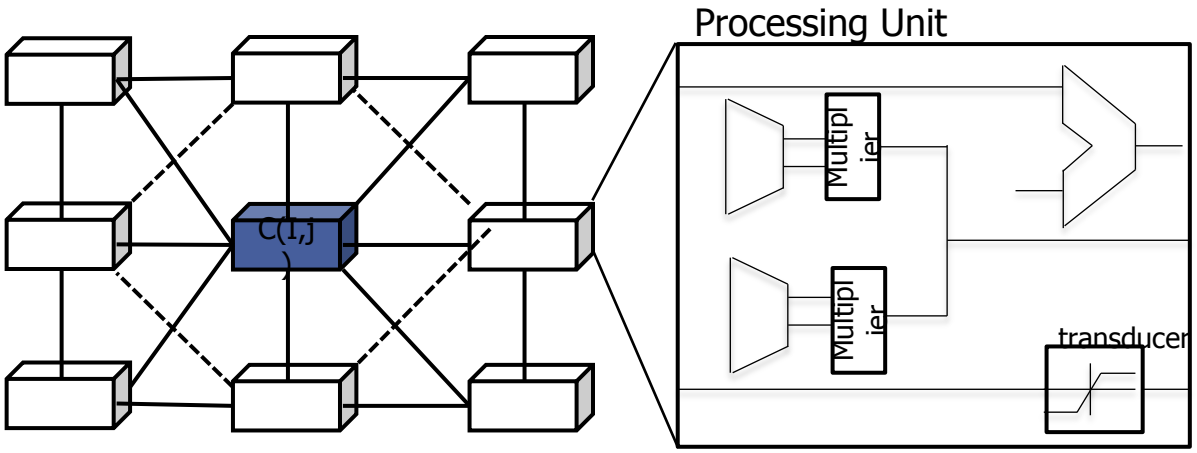
- Energy, energy, energy or efficiency, efficiency, efficiency
- Many sensors
  - Camera (video)
  - Audio, Wi-Fi, GPS, temperature, health related sensors, accelerators
- Security, Privacy

vs.



Low-Energy Video Processing

- Cellular Neuron Network Processors
  - a neuron-network computing paradigm, used in variety of applications
  - Proposed by Chua and Yang in 80s.
- Very well suited for image processing applications
  - Only local connections → short wire. low energy consumption
- Consume very little power



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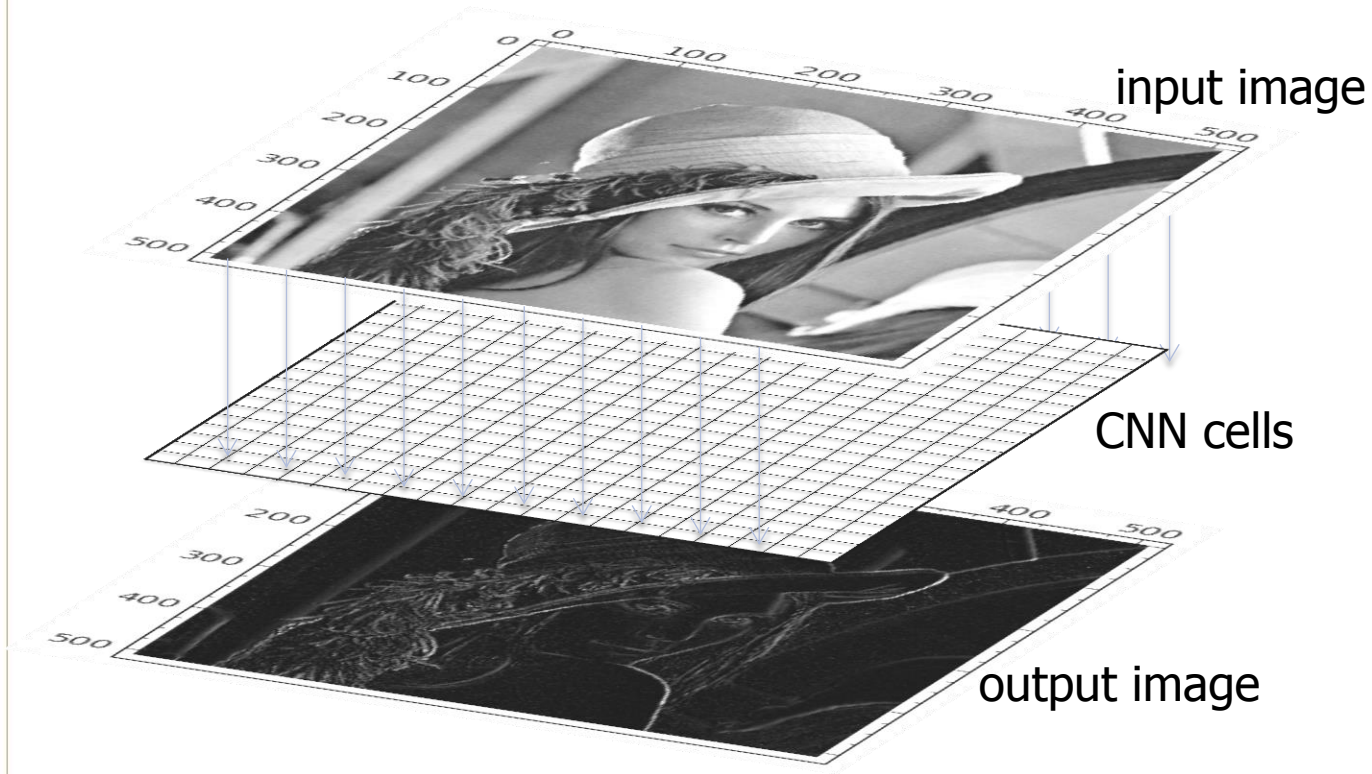
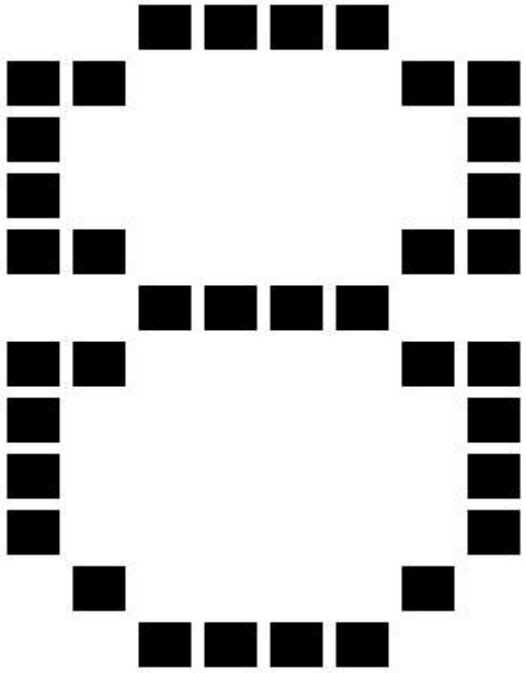
CNN



Example of CNN Program

- Global information is passed through cells
- Other applications:
  - More complicated image processing algorithms
  - Optimal path finding
  - Character recognition
- Challenges of CNN
  - **Image size scalability**
    - **Scalable CNN [GT]**
  - **Difficulty of programming**
    - **Learning templates**



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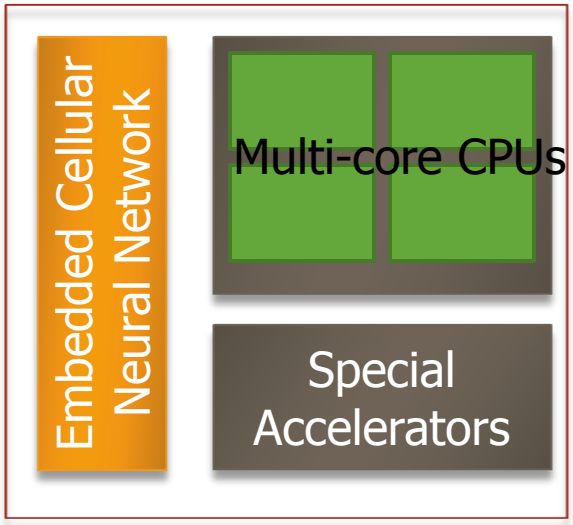
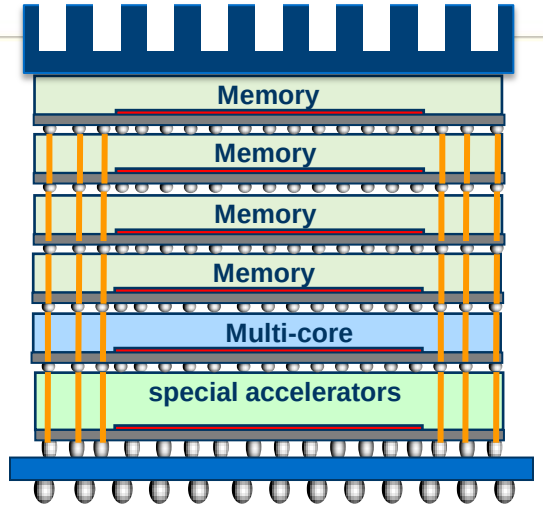
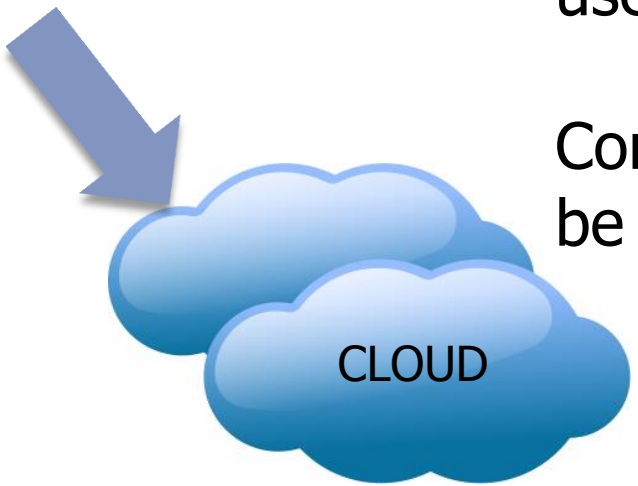
With Other Computing





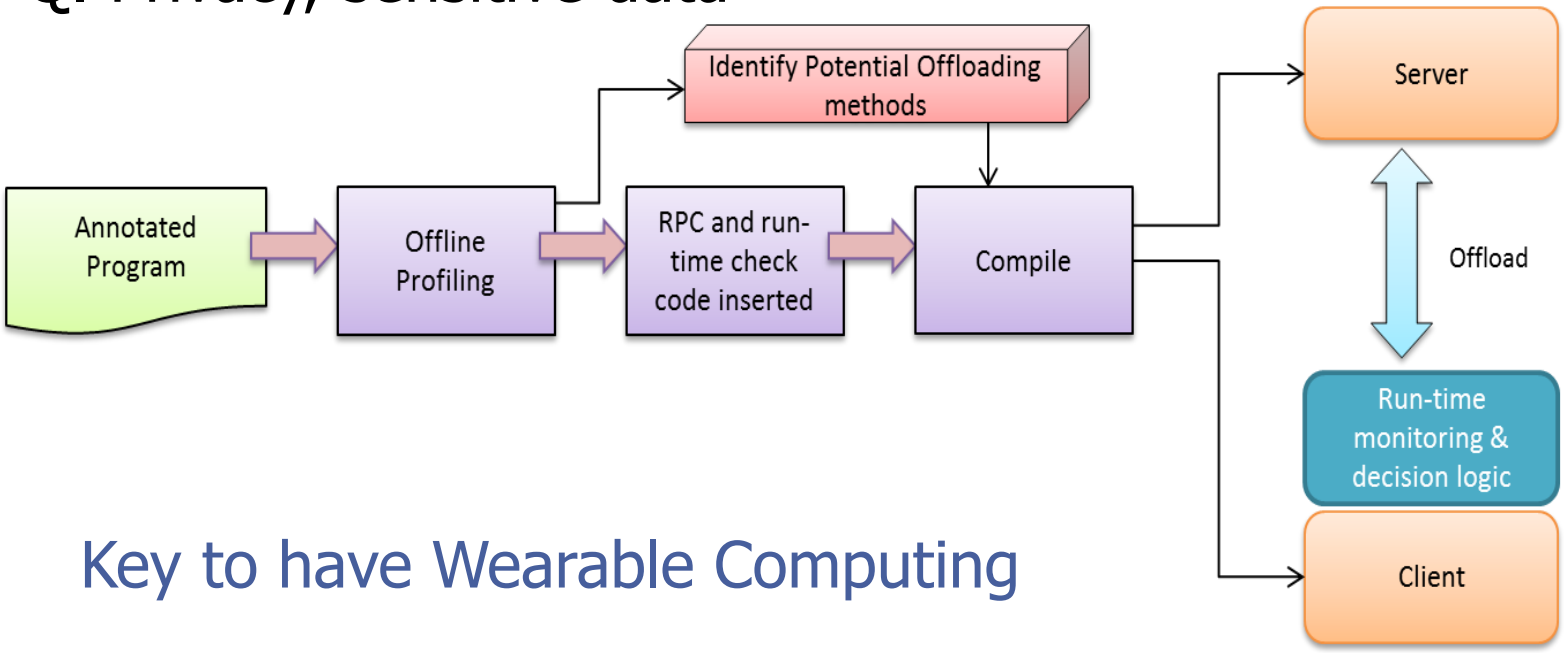
Video sensor processors are used for front-end processors



Complex computations will be handled in multi-core CPUs

Cloud Off Loading Computation

- Computation can be further offloaded to Cloud
- Performance and energy savings
- Q. What to offload?
- Q. Privacy, sensitive data



Key to have Wearable Computing

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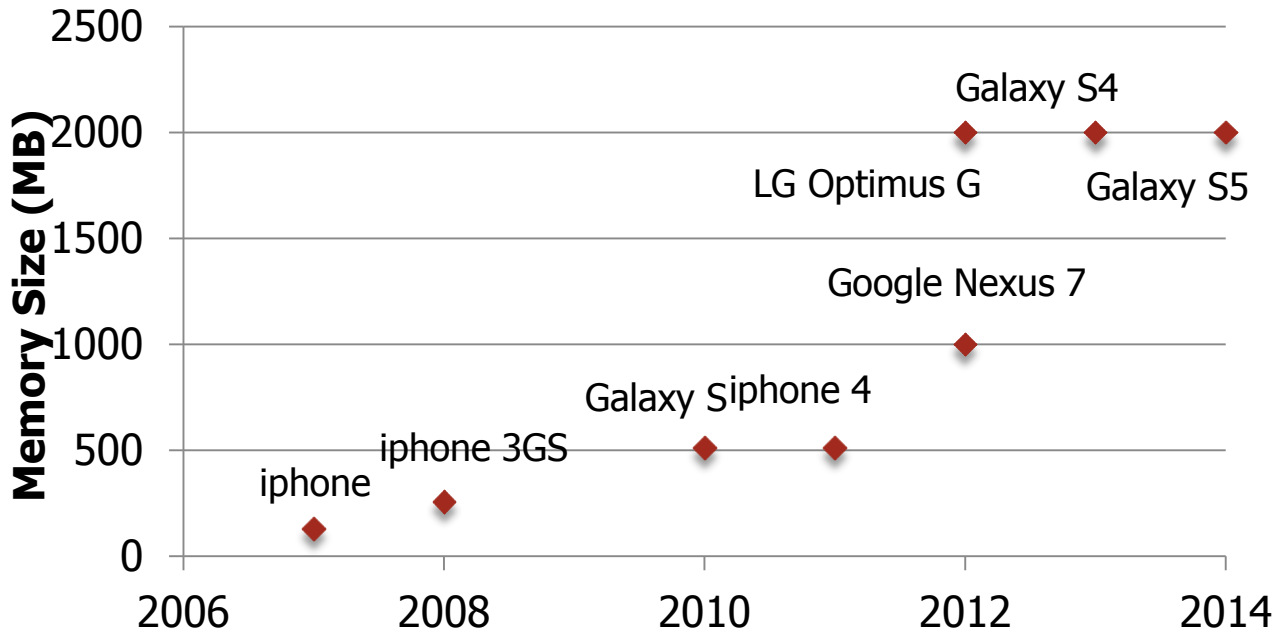
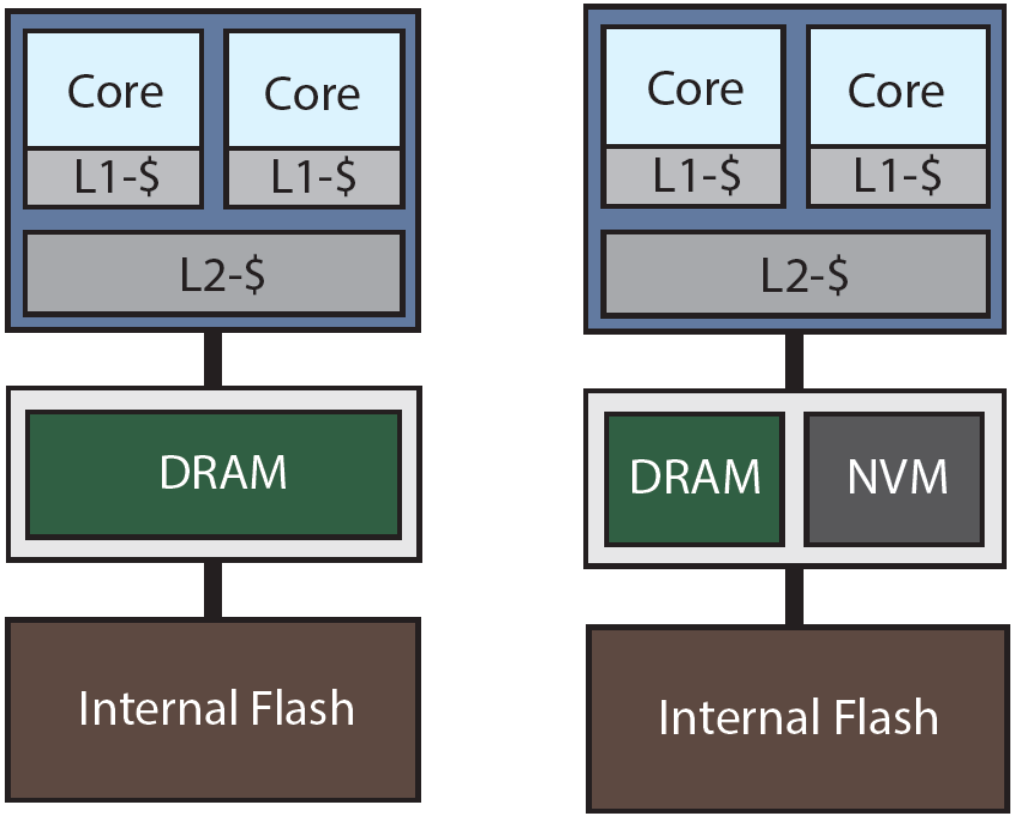
Another Opportunity to Save Energy

- Memory size



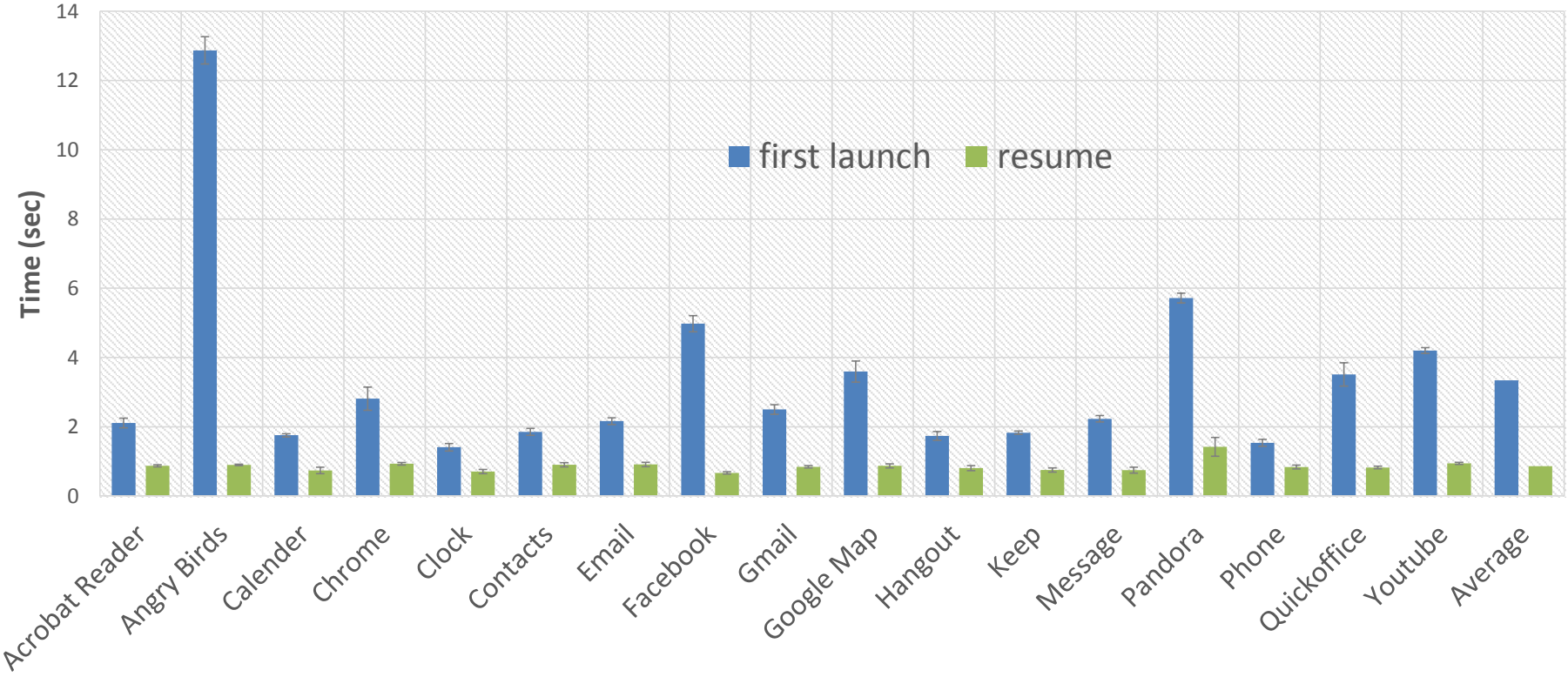
Energy Savings with NVM



Current Mobile Systems

Mobile system with NVM

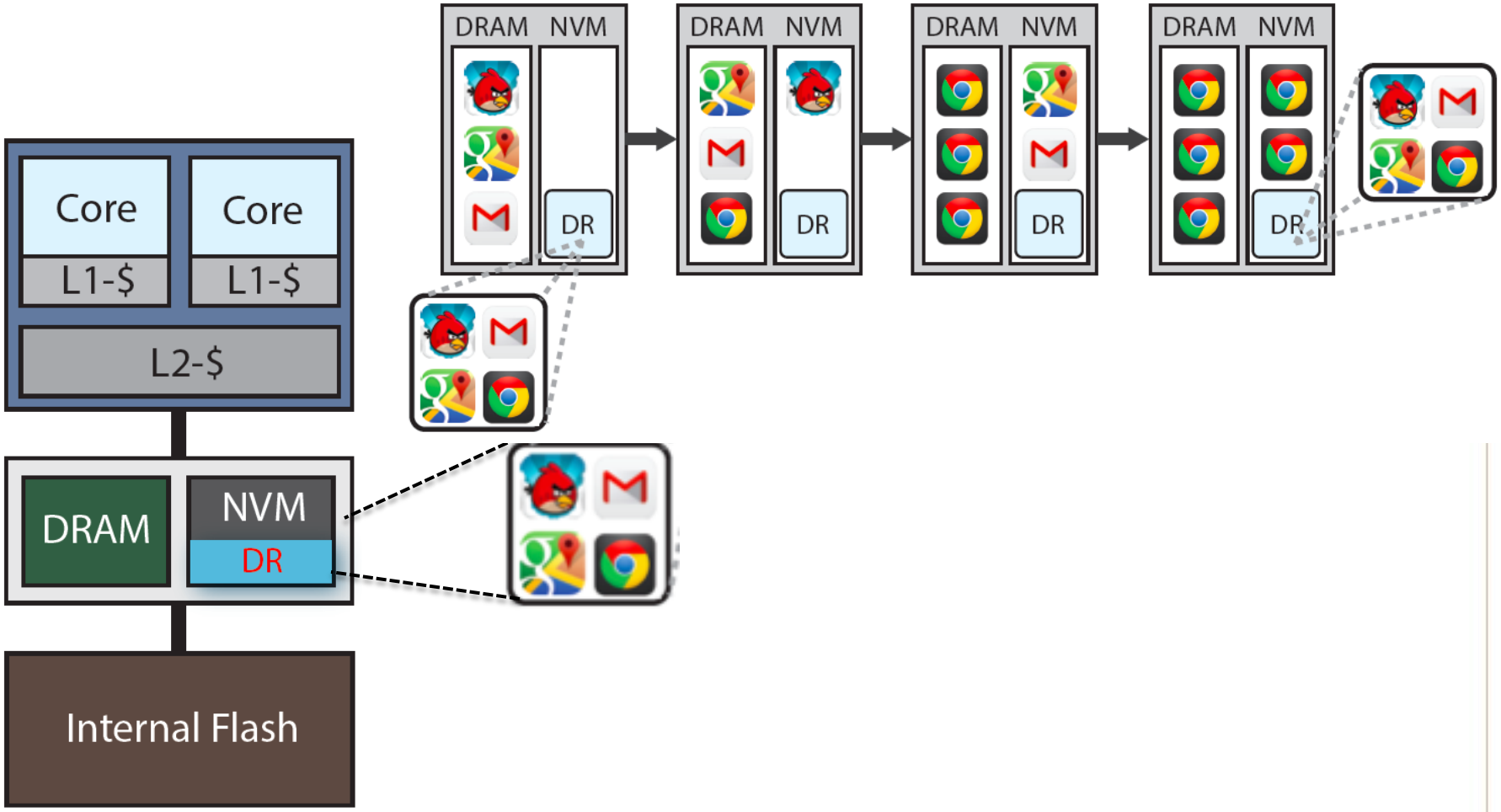
Start-up Time of Android Applications



First launch takes several seconds.

Reducing Start-up Time

- Dedicated Region for Start-up code



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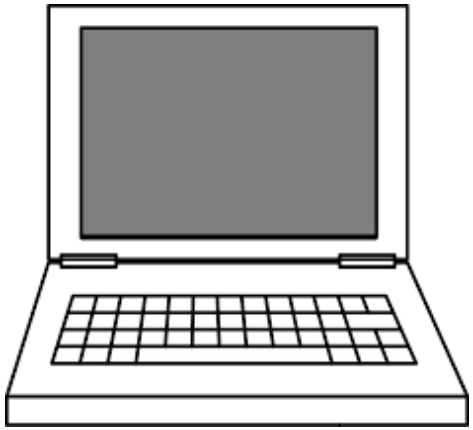

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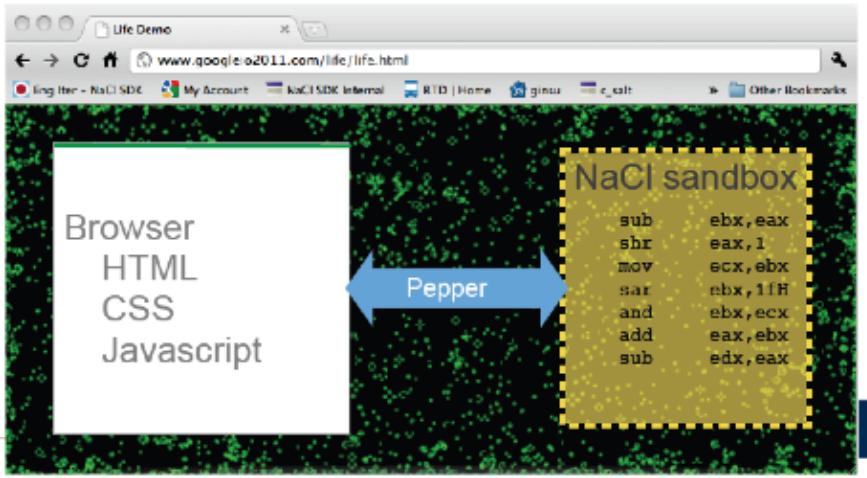
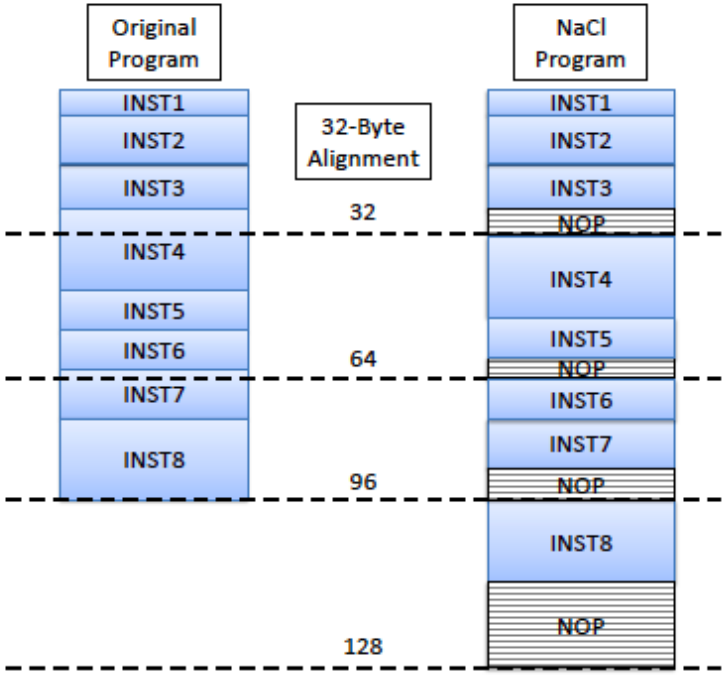
Security and Performance

- Tradeoff between security and performance
- Example: Google's Native Client Platform (NaCl)
  - Run natively compiled applications in the browser
  - Application execution is **secure**
- Secure execution through:
  - Elimination of unsafe instructions
  - Safe branch jumps
  - **Safe function calls and function returns**



Safe Function Calls and Returns

- To provide secure environment, all instructions are bundled.
- Before jump, always check. Even for function calls!




```
0x…00 bundle_start:
          ...
0x…1B     nop
0x…1C     and $0xffffffffffffffe0,%rcx
0x…1E     call *%rcx
0x…20 return_loc:
        <bundle aligned return>
          ...
0x…A0 nacl_function: <bundle aligned>
          ...
0x…A9     pop %rcx
0x…AA     and $0xffffffffffffffe0,%rcx
0x…AC     jmp *%rcx
```

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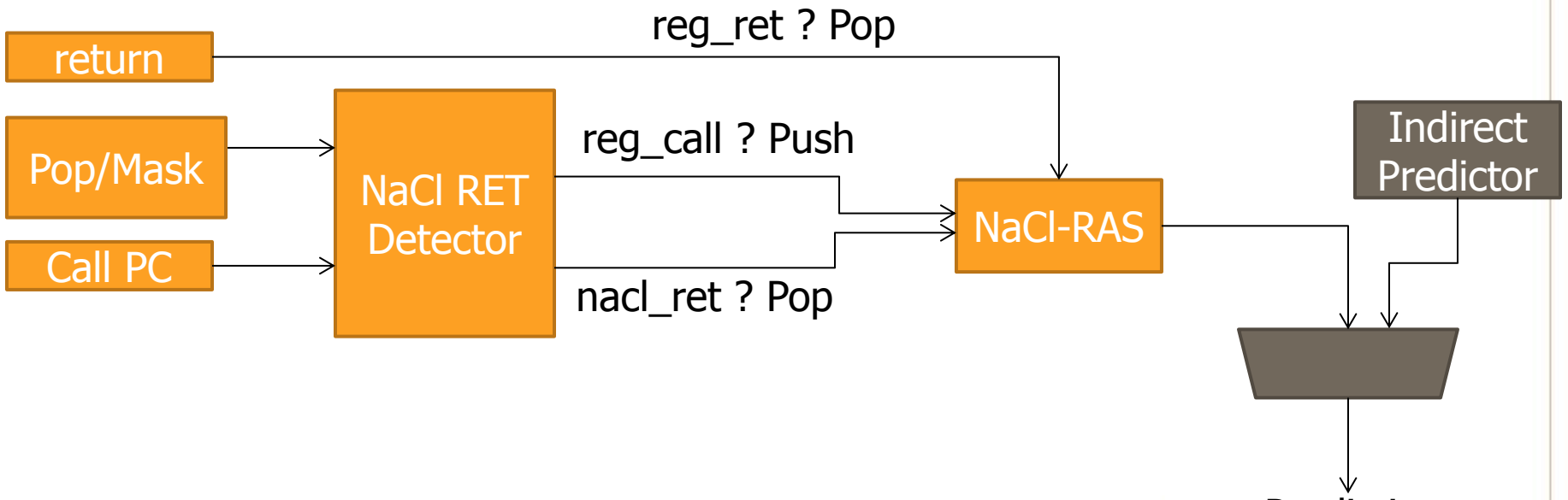
NaCl-RAS Mechanism

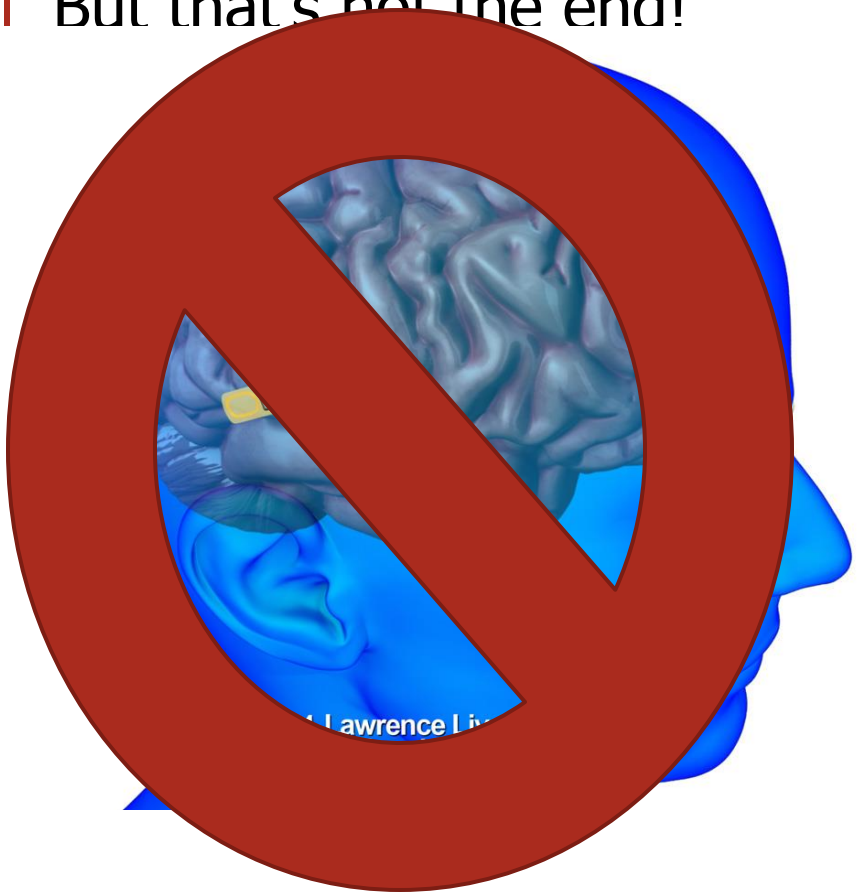
- Solution: Simple! detect a pattern and store the return address in a stack

- Lessons: Security solutions can create new branch prediction problems.



Conclusions

- Still Lots of challenges/Issues in Mobile Platforms
  - Energy, efficiency, security etc.
- But that's not the end!



Energy, **Security, Reliability, and performance**

Thank you

& Thank Yale!

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Acknowledgements

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